# Chapter 5
# Fused Deposition Modelling of Polylactic Acid (PLA)-Based Polymer Composites: A Case Study

**Murugesan Palaniappan**
*College of Engineering, Imam Mohammad Ibn Saud Islamic University, Saudi Arabia*

**Satyanarayana Tirlangi**
https://orcid.org/0000-0001-8265-8743
*Visakha Institute of Engineering and Technology, India*

**M. Jinnah Sheik Mohamed**
*Nellai College of Engineering, India*

**R. M. Sathiya Moorthy**
*PERI Institute of Technology, India*

**Srinivas Viswanth Valeti**
*Aditya Engineering College, India*

**Sampath Boopathi**
https://orcid.org/0000-0002-2065-6539
*Muthayammal Engineering College, India*

## ABSTRACT

*In this chapter, a case study on polymer composites made using the fused deposition modelling (FDM) process is exemplified. The fundamentals of the additive manufacturing process, such as stages, applications, classifications, disposal methods, material selection, general principles of FDM, and selection process parameters, have been explained. The case study focuses on creating practical four-dimensional feedstock filament prototypes out of polylactic acid (PLA), polyvinyl chloride (PVC), wood powder,*

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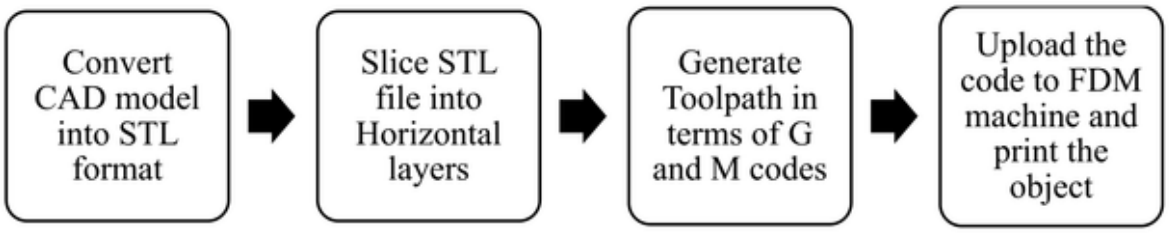
*and Fe3O4 powder for making quality FDM printed polymer composites. The procedure for making composites using the best combination of FDM process parameters has been illustrated using real-time experimental approaches.*

## INTRODUCTION

Additive manufacturing, also known as 3D printing, is a new technique that will revolutionise the way that products are designed and made. Products are manufactured in three dimensions using a method of mass production known as "3D printing." Due to the setup's minimal cost, additional adjustments are simple to implement. Numerous industries, including agriculture, the automotive industry, aerospace, and healthcare, have used 3D printing. In the manufacturing sector, this technology has developed into a more adaptable and potent method (Khan & Shaikh, 2014). The effectiveness and potential of additive manufacturing technologies demonstrate superior outcomes over traditional production methods.

*Figure 1. Various Stages of Additive Manufacturing Process*




The process of creating objects via 3D printing is known as additive manufacturing (AM). The various stages of additive manufacturing process are shown in Figure 1. The fusing of layers and the materials used in pattern creation are used to categorise AM procedures. Binder jetting, material extrusion, sheet lamination, powder bed fusion, and vat photopolymerization are a few of the important procedures. AM is a process of digital mass-production techniques that has revolutionised the industrial sector. It uses 3D CAD models for manufacturing, which eliminates the need for any additional tools. AM has changed the way that items are made so that they are both sturdy and light. One of the low-cost AM processes for a variety of thermoplastics and thermoplastic composites has received a lot of attention is fused deposition modelling (FDM). For FDM applications, a wide variety of polymeric materials, including polylactic acid (PLA), acrylonitrile butadiene styrene (ABS), polyamide (PA6), and polyvinyl chloride, are accessible. One of the common materials for FDM applications is PLA. Numerous research organisations have thoroughly investigated biocompatibility problems. For the purpose of creating multi/hybrid composites that support 4D applications, PLA was reinforced with PVC, wood powder, and magnetite powder ($Fe_3O_4$) (Mazurchevici et al., 2020; Testad et al., 2013). When activated by an external magnetic field, the material matrix is intended to develop the ability to self-assemble (as stimulus). The newly created composite matrix's 4D capacity has been added using $Fe_3O_4$ powder. Twin-screw extrusion was used to generate the material matrix as feedstock filament, which was then used in an FDM setup for 3D printing. The classification of additive manufacturing processes is illustrated in Figure 2.